Predicting the spotted lanternfly dispersal in the United States

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Outline

• Spatial Analytic Framework for Advanced Risk Information Systems
• Development of a stochastic spread model
• Case study on spotted lanternfly
• Summary
• Funded by USDA APHIS PPQ Science & Technology

• SAFARIS is a framework that can rapidly integrate new data, models, and tools to support PPQ’s mapping needs.

• Why framework?
  • Data gathering and processing
  • Multiple models and tools
  • Multiple pests
  • Easier to collaborate
Maximum Temperature

Grid Cell (38.59375, -121.46875)

Emissions continue to rise strongly through 2050 and plateau around 2100 (RCP 8.5)

Range of annual average values from all 32 LOCA downscaled climate models

- Modeled Variability Envelope
- Observed Data (1950–2005)

Modeled Data (2006–2099)
- HadGEM2-ES
- CNRM-CM5
- CanESM2
- MIROC5

Cal-Adapt

Historical Annual Mean for 1961–1990
74.2°F Observed

Modeled Projected Annual Mean for 2070–2099
82.7°F
PestCAST: Near-Real Time Phenology and 30 Day Forecasts

- Connected to NOAA and other databases
- 7 day weather forecasts
- 20-year of historical data
- Web-based tool
Plant Hardiness Zones

Global Plant Hardiness Zones

Click on the map to find your zone information.
Plant Hardiness Zone:
Hover over a region.

Transparency

Longitude: -129.02 Latitude: 42.81
Annual Weather Variability

Difference between Annual Accumulated Physiological days and 1996-2015 Average Annual accumulated Physiological Days for Boll Weevil

2005

2006

2007

2008

2009

2010

2011

2012

2013

2014

2015

2016

Degree Days

Base developmental temp: 9°C

Upper developmental temp: 35°C

Sources: Greenberg et al., 2005; SAFARIS, 2017
Projection: USA Conoquenessa Albers Equal Area Conic
Date: October, 2017
Created by: T. Teleshov (NDSU CIFM)
Predicted *Helicoverpa armigera*: Flight Times March 1 to April 15
Long-term Forecast: Oriental Fruit Fly

- 20 MACA downscaled GCMs
- RCP 8.5
- Southern US is expected to have 2-3 more generations in the future
Development of a stochastic spread model
Model that could generalize to multiple pests/pathogens

The **POPS** tool suite includes:

- Data prep
- Calibration
- Validation

Interactive Interface (In Development)

Installation instructions at popsmodel.org
Model

Number of pests moving from one location to another

\[ \psi_{ijt} = \beta (X_{it} P_{it} T_{it} I_{it}) \times K(d_{ij}; \alpha_1, \alpha_2, \gamma) / d_{ij} \times \left( X_{jt} P_{jt} T_{jt} S_{jt} / N_j \right) \]
How many hosts in cell $j$ are infested as a result of pests from cell $i$?

$$\psi_{ijt} = \beta(X_{it}P_{it}T_{it}I_{it}) \cdot K(d_{ij}; \alpha_1, \alpha_2, \gamma) / d_{ij} \cdot \left( X_{jt}P_{jt}T_{jt}S_{jt} / N_{j} \right)$$

$\psi_{ijt}$ = number of infested hosts in $j$ as a result of pests from $i$.
How many hosts in cell j are infested as a result of pests from cell i?

\[ \Psi_{ijt} = \beta(X_{it} P_{it} T_{it} I_{it}) \ast \frac{K(d_{ij}; \alpha_1, \alpha_2, \gamma)}{d_{ij}} \ast \frac{(X_{jt} P_{jt} T_{jt} S_{jt})}{N_j} \]
How many hosts in cell $j$ are infested as a result of pests from cell $i$?

$$\psi_{ijt} = \beta (X_{it} P_{it} T_{it} I_{it}) * K(d_{ij}; \alpha_1, \alpha_2, \gamma) / d_{ij} * \left( X_{jt} P_{jt} T_{jt} S_{jt} / N_j \right)$$
Spotted Lanternfly in Pennsylvania:

- Native range: China, Vietnam, India
- Discovered in PA in 2014
- 16 counties quarantined
- Has also been found in New Jersey, Delaware, Virginia, and Maryland.

Management effort by:

Sucks the sap out of branches and stems!
PoPS Dashboard

Parameter settings

• Years for model calibration
• Years for the model forecast
• Host information
• Weather data inputs
• Temperature requirements for SLF growth
When the PoPS Dashboard first loads, it displays the field observations used to calibrate the case study.
Spread Predictions

Prediction for 2018

Prediction for 2019

Prediction for 2020
Tangible Landscape
https://tangible-landscape.github.io/index.html

- Tangible freeform modeling
- Visualization
- Real-time geospatial analytics
- Participatory research
• 3D Topographic background (optional)
• Grass GIS & R
• Felt represents treatment
PoPS – Tangible Landscape

• Real time simulation to forecast pest spread by implementing management strategies proposed on the Tangible Landscape

• Calculates economic damages and management costs

• Visualizes effectiveness of proposed management scenarios instantly

• We want to use forecasted weather data for the prediction instead of averaged weather data

• Making update on the dashboard to easily compare different scenarios
Summary and Conclusions

• The main objective SAFARIS is to create a framework to meet PPQ’s predictive mapping and modeling needs with regard to informing surveys, operations and policy.

• Supporting PPQ’s activities by developing new models and tools.

• Looking for new ideas to better predict pest activities at global scale in a timely manner.
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